Packet Drop Analysis with Variation in Area and Number of Nodes in MANET

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Abstract

Mobile Ad hoc NETwork (MANET) are very helpful in situations where wired or wireless network, with some infrastructure, are not feasible. In such areas there are various possible challenges: open channel, surrounding environment, resource scarcity. All these factors somehow prevent a MANET from working efficiently. Node/s in the network may drop all kind of packets and disturb the network activities to achieve its goal. Packet dropping is a serious issue. It can lead to data loss as well as disruption in routing and acknowledgement process. This paper analyzes variation in packet dropping nodes, by varying number of nodes, keeping the working area constant and by varying working area, keeping the number of nodes constant. Results obtained after analysis will be useful to find out optimum number of nodes in an area. Outcome of the current work will lead in efficient working of network.

1. INTRODUCTION

Mobile Ad hoc NETworks (MANET) are applicable in such circumstances where wireless network (with some infrastructure) are not apposite for deployment. Characteristics of mobile ad hoc network make them susceptible during its operations. MANET nodes are equipped with less resources like battery power, bandwidth, computing power etc. as compare to wired network nodes. Node/s of network helps other node/s of network in packet (in general terms) forwarding activities. These intermediate nodes are act as router for other nodes [1]. Any node in network transmits many types of packets. MANET face packet dropping problem. The packets that can be dropped, by any node in MANET, are: data packets, acknowledgement packets, connection establishment request-reply, route request-reply etc. Any kind of dropping of packet is serious issue in network. It creates hurdle in network activities. There are various reasons of packet dropping. One of the reason is the scarcity of resources. Node unknowingly or deliberately, to save its available resources, do not participate in network activities. The node only transmits its own packets and drop all other incoming packets of other nodes of network.

Another reason of dropping of any type of packet is the high communication range between nodes of network. If a node is trying to transmit data to a distant node, packet may not reach to its intended destination and dropped in between. Node mobility is another reason of packet dropping. Consider a situation in which a node either transmits its own data packet or forwards a packet of another node to its neighboring node, due to high mobility, neighbor node can move quickly from its current position and unable to catch the incoming packet. Node density causes network congestion that results in packet dropping [2] [3].

This work focuses on analysis of packet dropping in MANET. It helps to analyze variation in packet dropping nodes. To carry out the analysis, work is divide in two ways. They are:

1) Varying the number of nodes and keeping the working area constant.

2) Varying the working area and keeping the number of nodes constant.

The main purpose of this analysis is to find out the optimum number of nodes in both the situations so that MANET performs efficiently in each and every condition [4]. Since the actual data for such conditions are not available therefore to capture the data, simulation was performed using Network Simulator-2 (NS-2).

To analyze both the conditions, simulation is carried out by setting the required few parameters. Though NS-2 simulation for wireless network having number of parameters like channel type, number of nodes, simulation start and stop time, protocol used, energy provided to each node, area for simulation, queue length etc. Out of these parameters, the preferred parameters for this work are: number of nodes, area for simulation, time for simulation, protocol used, energy provided to each node. Brief detail of these parameters are:

a) Number of nodes: To get various result, the value of this parameter is kept constant and varying by certain scale.

b) Area of simulation: This parameter keep either constant or varying for different phase of analysis.

c) Energy: All nodes in the network are provided sufficient energy so that network run efficiently.

d) Time: This parameter was set such that study will record all activities during simulation.

e) Protocol: Ad hoc On demand Distance Vector (AODV) routing protocol is used.

The paper is further arranged in following ways. Section II gives literature review. Section III is description of proposed method. Section IV is result and discussion. Section V provides Conclusion.

2. LITERATURE REVIEW

MANET characteristics makes them prone to attack. Packet dropping also comes under attack category. To avoid such attacks some economy based scheme must be applied. To discard such nodes from network, detection techniques are applied to know their pros and cons [2] [7]. Packet dropping in a wireless ad hoc network may occur due to link error and by the malicious node/s. Packet dropping sometimes are undetectable in network. An accurate calculation is required that finds whether packet loss is equal to channel error rate. Some investigators are used to get details about truthfulness of packet drop report [3]. Nodes in the network may create group and drop either few or all packets. A Dynamic Source Routing (DSR) based technique Cooperative Bait Detection Scheme (CBDS) used, that easily find out such nodes in network [5]. Malicious node/s also drops packets in network. To detect them various techniques are used: they are Watchdog, PathRater, Side Channel Monitoring (SCM), Monitoring Agent, Sequence Number Model and Two Ack on various parameters [6]. Nodes in network sometimes deliberately drops packet of other legitimate nodes; to encourage them Attack-Resilient Cooperation Stimulation (ARCS) system is applied to achieve fairness among the nodes. It is self- organized and fully distributed [8]. Packet loss are also possible due to node mobility and congestion in network. A simulation study by taking Ad-hoc On-demand Distance Vector (AODV) and Destination-Sequenced Distance Vector (DSDV) shows that for User Datagram Protocol (UDP) type traffic, DSDV drops around 20% more packets in comparison of AODV, while for TCP flow the losses are 50% less than AODV. AODV faces 60% of total packet loss due node mobility. On the other hand, DSDV faces 50% of total packet loss due to congestion [9].

3. PROPOSED METHOD

Packet dropping is very dangerous for any type of network. Sometimes it becomes difficult to identify such nodes in the network. [7] The work proposes analysis of variation in packet dropping nodes in MANET. The analysis is carried out in two ways. Each part is described in detail.

3.1 Varying the number of nodes and keeping the working area constant.

To accomplish this analysis, two parameters: area and number of nodes are taken. Here, number of nodes keeps varying and working area keep constant. For this part the suitable simulation parameters selected are described below:

a) Number of nodes: This parameter is set to obtain various result, the value of this parameter is kept varying on the scale of 5. Initially simulation starts with 10 number of nodes in the network. The simulation is carried out till 55 number of nodes i.e. for 10 values.

b) Area of simulation: This parameter, in part one, kept fixed for each variable number of node. Initially its value is set as 800*800. To check the variation in packet dropping node/s, in second part, its value is varied on the scale of 400. The last study is carried out for the area of 2400*2400.

c) Energy: All nodes in the network are provided with sufficient energy, so that nodes of network will not die earlier and all nodes can communicate easily with neighboring node/s. The initial energy provided to each node is 1000 joule.

d) Time: This parameter was set such that analysis study will records all possible activities during simulation. It helps to capture possible realistic result of simulation. The start time of simulation is set at 1.0 and the stop time of simulation is set at 100.0.

e) Protocol: The routing protocol selected for this simulation process is Ad hoc On demand Distance Vector (AODV). This routing protocol is reactive protocol and does not uses large bandwidth.

In general, before simulation process the communication between nodes are defined by the user i.e. user defines the pair of nodes. In this work, the communication pairs are generated randomly. The work assumed that 30% pair of working nodes are communicating in the network, e.g. for 10 nodes network, 3 pairs or 6 nodes are communicating in the network.

Rest all other parameters for the simulation are set on their standard values, generally using during normal wireless network simulation.

The simulation result provides details like node id, next hop id, send, receive, drop, forward details along with type of packet like tcp, udp, ack etc., position of node on x-y-z axis, time, energy and many more in text format. The details produce by any trace file is looks like:

s -t 6.732783899 -Hs 6 –Hd -2 -Ni 6 -Nx 73.89 -Ny 112.57 -Nz 0.00 -Ne 992.907639 -Nl AGT -Nw — -Ma 0 -Md 0 -Ms 0 -Mt 0 -Is 6.0 -Id 4.0 -It tcp -Il 1064 -If 1 -Ii 737 -Iv 32 -Pn tcp -Ps 153 -Pa 0 -Pf 0 -Po 0

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This data is extracted in tabular format, which is given in table-I. It shows only few parameters, rest all parameters are not included here. The parameters relevant for this work are: packet send, packet receive, packet drop and packet forward by a node. Based on the parameters shown in table-1, **(Annexure-I)** a new table-2 with required parameters is created.

Table-2: Send, Receive, Drop and Forward Packet Details for 10 Nodes

Node	Send	Receive	Drop	Forward
1	378	378	52	0
2	761	761	83	130
3	0	0	69	580
4	412	360	65	0
5	915	915	103	1
6	0	0	6	0
7	957	893	89	208
8	0	0	20	50
9	0	0	21	74
10	803	736	73	0

Using table-2 data, drop ratio is calculated for each node of mobile network. Its value is obtained by taking the packets dropped by a node over sum of packets send, forward and drop by a node. As it is also discussed that a node due to certain reasons drops all other incoming packets, therefore it is required to sum up all these data packets that are gone through a node. To calculate drop ratio following formula has been used.

$$\text{Drop Ratio} = \frac{\text{Number of Packets Dropped}}{\text{Packet Send} + \text{Packet Forward} + \text{Packet Drop}} \quad (2)$$

This drop ratio is the parameter that decides which node is dropping packets in bulk. Its value must be between 0 to 1. This analysis, helps to find a node which is dropping packet beyond a limit or not, drop ratio for such a node is set to 0.4. Since any node/s is easily compromised or due to selfishness it can drops packet of other node/s [7]. In any awkward situation, it is desired that network must work efficiently. This is given as tolerance factor [4]. A tolerable limit for drop ratio was set to 0.4. There is no certain rule for drop ratio. For other analysis and other situations this value can be changed. Table-3 shows the drop ratio calculated for a node along with packet dropping node calculation. It shows the details of 10 number of nodes for 800*800 area, it is found that only 1 node exist in the network that excessively dropping packets.

Table-3: Drop Ratio Calculation Details for 10 Nodes (Area: 800*800)

Node	Send	Receive	Drop	Forward	Drop Ratio	Drop Ratio>=0.4
0	378	378	52	0	0.1209	0
1	761	761	83	130	0.0852	0
2	0	0	69	580	0.1063	0
3	412	360	65	0	0.1362	0
4	915	915	103	1	0.1010	0
5	0	0	6	0	1	1
6	957	893	89	208	0.0709	0
7	0	0	20	50	0.2857	0
8	0	0	21	74	0.2210	0
9	803	736	73	0	0.0833	0

In the same manner drop ratio along with packet dropping node, for 15 to 55 nodes, for area of 800*800 are calculated The analysis is further carried out for working areas ranging from 1200*1200 to 2400*2400. The results obtained are presented in table-4.

Table-4: Packet Dropping Node Details for Given Area and Varying No of Nodes

No of Nodes→ Area ↓	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**
800	*1*	*7*	*13*	*11*	*21*	*28*	*32*	*44*	*48*	*55*
1200	*5*	*6*	*9*	*16*	*16*	*30*	*36*	*45*	*42*	*55*
1600	*2*	*6*	*9*	*16*	*22*	*29*	*38*	*43*	*47*	*53*
2000	*2*	*6*	*11*	*17*	*21*	*25*	*33*	*41*	*47*	*53*
2400	*3*	*9*	*12*	*20*	*21*	*26*	*37*	*43*	*43*	*51*

The data shown in table-IV is also represented graphically in fig.-1 and fig.-2.

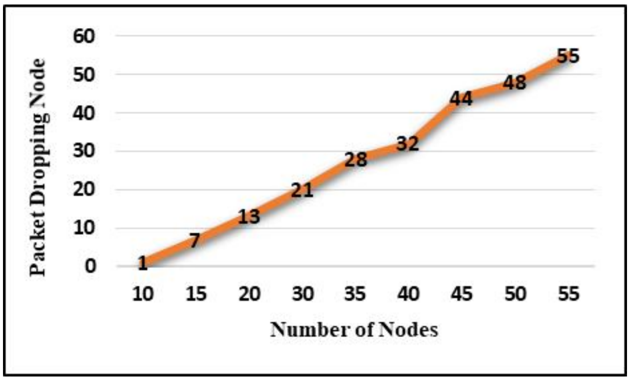

Fig.1: Packet Dropping Node Details for Area 800*800

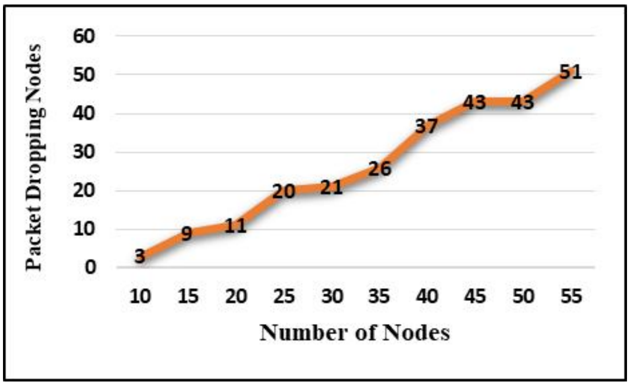

Fig.2: Packet Dropping Node Details for Area 2400*2400

This rigorous analysis realizes that as the number of nodes increases, the number of packet dropping node also increases.

4. RESULT AND DISCUSSION (VARYING NODES)

The calculations are carried out to find out the variation in packet dropping nodes as an effect of increasing in number of nodes and keeping working area constant. Variation in number of nodes is done in multiple of 5. The above values are calculated for specific data. It became important to find out the results in between values. For measuring the in between values, the interpolation has been applied to get estimated unknown values between two known values [10]. To calculate these values, the following interpolation formula, eq. (2) has been used.

$$y=a_1 + a_2 * (x) + a_3 * (x^2) + a_4 * (x^3) + ... + a_n * (xn^{-1}) \quad (2)$$

The eq. (2) can also be represent or written as eq. (3)

$$y=a_1 + a_2 * (x-x_1) + a_3 * (x-x_1) * (x-x_2) + a_4 * (x-x_1) * (x-x_2) * (x-x_3) + ... + a_n * (x-x_1) * .. * (x-x_{n-1}) \text{ eq.} \quad (3)$$

The coefficient $a_{1,}\ a_{2...}\ a_n$ in eq. (3) were calculated for various combinations of 'x' ranging from 10 to 55. The value of x and y are taken here is the number of nodes and number of packet dropping nodes respectively. E.g. (10,1), (15,7) and so on. These coefficient values were also depicted in table-5. **(Annexure-II)**

The table-5 depicts values of calculated coefficients for varying number of nodes and for constant area of network. The calculated values are used to find out random unknown values between two known points. To find the final equation, average of each coefficient has taken and that value is used to find out the required results. The final equation with average of coefficient and number of node is given in eq. (4)

$$y=(2.6) + (0.84) * (x-10) + (-0.02) * (x-10) * (x-15) + ... + (3.43228\text{E-}10) * (x-10) * (x-15) * .. * (x-55) \quad (4)$$

To calculate number of packet dropping nodes for a specific number of nodes, the above equation is used. E.g. for 22 number of nodes, the number of packet dropping nodes are 13.

4.1 Varying the working area and keeping the number of node constant

In next part i.e. keeping the working area increasing on certain scale and keeping the number of node constant. In this condition, the area of network is varied in multiple of 400. The range of working area is taken from 800*800 to 2400*2400. The analysis starts with working area of 800*800 and the number of nodes keep constant at 10. To perform this analysis with various combinations, all required simulation parameters like area, number of nodes, initial energy, start and stop time of simulation and routing protocol are set similar to previous part. The communication pair establishment is also done randomly. Based on simulation data, all other calculations, like drop ratio and number of packet dropping nodes in an area, are performed in similar manner describe in section III. The result obtained for number of packet dropping node varies after increasing in working area are shown in table-6.

Table-6: Packet Dropping Node Details for Varying Area and Constant Number of Nodes

Area→ No of Nodes↓	800	1200	1600	2000	2400
10	1	5	2	2	3
15	7	6	6	6	9
20	13	9	9	11	12
25	11	16	16	17	20
30	21	16	22	21	21
35	28	30	29	25	26
40	32	36	38	33	37
45	44	45	43	41	43
50	48	42	47	47	43
55	55	55	53	53	51
AVG	**25.9**	**26**	**26.4**	**25.4**	**26.4**

The data given in table-6 can also be represent graphically. It is shown in fig.-3 and fig.-4.

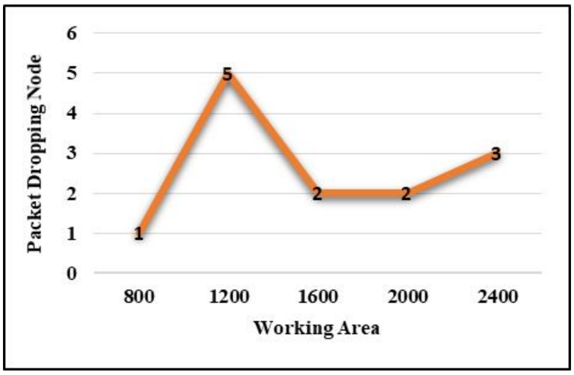

Fig.3: Packet Dropping Node Details for 10 Nodes

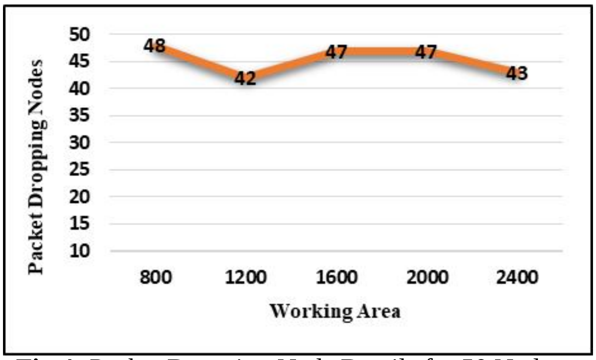

Fig.4: Packet Dropping Node Details for 50 Nodes

4.2 Result and Discussion (Varying Area)

The above graphs only provide the results based on increasing working area. It is observed that by increasing the working area, how the number of dropping nodes will increase is uncertain. To find out the variation in number of dropping nodes, double interpolation equation is used [10]. This equation requires two parameters to calculate specific number of packet dropping nodes. The two parameters are: working area of network and working node were taken as x and y respectively, represented in eq. (5).

$$z = f(x,y) \tag{5}$$

These two parameters will help to find out the specific value of number of dropping nodes in specific area when it will have specific number of nodes. The eq. (6) to eq. (10) is used to obtained the desired result

$$a_1 = \frac{(x_1-x_2) * (y_2-y_0)}{(x_1-x_0) * (y_1-y_0)} \tag{6}$$

$$a_2 = \frac{(x_2-x_0) * (y_1-y_0)}{(x_1-x_0) * (y_1-y_0)} \tag{7}$$

$$a_3 = \frac{(x_1-x_2) * (y_1-y_2)}{(x_1-x_0) * (y_1-y_0)} \tag{8}$$

$$a_4 = \frac{(x_2-x_0) * (y_1-y_2)}{(x_1-x_0) * (y_1-y_0)} \tag{9}$$

$$p_4 = p_0*a_1 + p_1*a_2 + p_2*a_3 + p_3*a_4 \tag{10}$$

Table-7: Packet Dropping Node Details for Specific Area and for Specific Number of Nodes

Area	Nodes	Dropping Nodes
900	12	4
1000	47	45
1400	22	11
1500	16	6
1700	32	24
1800	27	18
2100	41	35
2200	36	27
2300	52	47

To calculate number of dropping nodes for specific area and specific number of nodes, table-7 shows few results, e.g. for area 1400*1400 and for 22 number of nodes, the number of dropping nodes are 11.

5. CONCLUSION

The main objective of the whole work is to find out the optimum number nodes that can be put in network so that network works efficiently. To achieve this simulation was done using NS-2. Firstly, by varying number of nodes and secondly by varying working area, other than this following parameters are set to perform simulation: area, number of node, initial energy, start and stop time and routing protocol. The data obtained after simulation are used to calculate the drop ratio with the help of packet send, packet forward and packet dropped by a node. Drop ratio decides whether a node in network is dropping packet excessively or not. The threshold value of drop ratio is set to 0.4. The results obtained are calculated for varying number of nodes from 10 to 55. To calculate in between values, interpolation has been applied. From the results it can be conclude, for varying number of nodes, that as the number of nodes increases the number of packet dropping nodes also increases. It looks like linear in nature.

In case of varying working area, the obtained results are not certain and it became difficult to predict about the effect on number of packet dropping node on one factor. To find out the specific number of dropping nodes between values, double interpolation is used. The two parameters used for double interpolation are: working node and the working area. The results based on these two parameters are given in table-7.

Future Scope: The current work has taken only two parameters and used interpolation to obtain the result. The work can be extended by using other suitable optimization techniques.

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(Annexure-I)

Table-1: Parameters Details after Simulation

S	-t	1	-Hs	3	-Hd	-2	-Ni	3	-Nx	0.78	-Ny	19.98	-Nz	0	-Ne	1000	-Nl	AGT	-Nw	--	-Ma	0	-Md	0	-Ms	0	-Mt	0	-Is	3	-Id	0	-It	tcp
R	-t	1	-Hs	3	-Hd	-2	-Ni	3	-Nx	0.78	-Ny	19.98	-Nz	0	-Ne	1000	-Nl	RTR	-Nw	--	-Ma	0	-Md	0	-Ms	0	-Mt	0	-Is	3	-Id	0	-It	tcp
S	-t	1	-Hs	6	-Hd	-2	-Ni	6	-Nx	10.97	-Ny	16.72	-Nz	0	-Ne	1000	-Nl	AGT	-Nw	--	-Ma	0	-Md	0	-Ms	0	-Mt	0	-Is	6	-Id	4	-It	tcp
R	-t	1	-Hs	6	-Hd	-2	-Ni	6	-Nx	10.97	-Ny	16.72	-Nz	0	-Ne	1000	-Nl	RTR	-Nw	--	-Ma	0	-Md	0	-Ms	0	-Mt	0	-Is	6	-Id	4	-It	tcp
S	-t	1	-Hs	9	-Hd	-2	-Ni	9	-Nx	13.62	-Ny	14.64	-Nz	0	-Ne	1000	-Nl	RTR	-Nw	--	-Ma	0	-Md	0	-Ms	0	-Mt	0	-Is	9.25	-Id	-1.25	-It	AODV
S	-t	1	-Hs	6	-Hd	-2	-Ni	6	-Nx	10.97	-Ny	16.72	-Nz	0	-Ne	1000	-Nl	RTR	-Nw	--	-Ma	0	-Md	0	-Ms	0	-Mt	0	-Is	6.25	-Id	-1.25	-It	AODV

(Annexure-II)

Table-2: Coefficient by Using Number of Nodes, Number of Packet Dropping Nodes and Keeping Area Fixed

Area	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}
800	1	1.2	0	-0.01067	0.0018	-0.00015	0.0000087	-0.000000335	7.42E-09	6.34E-11
1200	5	0.2	0.04	0.00266	-0.000867	0.00012	-0.00001066	6.882E-07	-3.53E-08	1.56E-09
1600	2	0.8	-0.04	0.01066	-0.001067	0.000072	-0.00000355	0.000000121	-2.22E-09	-3.38E-11
2000	2	0.8	-0.02	0.008	-0.001	0.0000746	-0.00000364	0.000000116	-2.09E-09	-8.46E-12
2400	3	1.2	-0.08	0.0146	-0.00173	0.000141	-0.000008	0.000000314	-8.38E-09	1.35E-10
AVG	2.6	0.84	-0.02	0.00505	-0.000573	5.152E-05	-0.00000343	1.8084E-07	-8.114E-09	3.43228E-10

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